

Great Lakes Environmental Research Laboratory

Laboratory Accomplishments

List 3-5 major accomplishments for your laboratory. If accomplishment occurred more than 2 years ago, cite recent progress. Please specify importance of accomplishment, who have been the major users and what has been the benefit to the taxpayer.

1. Great Lakes Coastal Forecasting System (GLCFS) operationalization

In 2003, GLERL operated the fully-implemented workstation-based version of GLCFS on computer systems at GLERL. GLCFS products are being disseminated from GLERL to NWS forecast offices through AWIPS (the NWS advanced weather information processing system) and used routinely in interactive graphical forecasts (IFPS: Interactive Forecast Preparation System) and as guidance for worded marine forecasts and warnings.

Customers: The results of this project will be useful to all users of the Great Lakes coastal waters who require real-time information and forecasts of temperatures, currents, water levels, and waves. Physical processes have a major impact on environmental, chemical, and biological processes and influence many other types of user activities, such as water supply management, waste water management, power plant sitings, shipping, recreational and commercial boating and fishing, shoreline erosion and redistribution of sedimentary material. Planners and managers responsible for any part of the Great Lakes ecosystem that is affected by lake circulation, such as transport of toxic material or nutrient enrichment processes, will have full access to the information provided by Great Lakes Coastal Forecast System (GLCFS) to assist them in their decision making processes. The forecasts of lake waves, water levels, water temperatures, and currents are expected to provide NWS marine forecasters with a significant source of new information, which should lead to considerable improvements both in the accuracy and efficiency of marine forecasts for the Great Lakes.

Significance: Making Great Lakes wave and circulation forecasts available to NWS forecasters at their workstations is the culmination of a ten year research and development effort at GLERL and Ohio State University to demonstrate the feasibility of operational coastal forecasts for the Great Lakes. The Great Lakes Coastal Forecasting System has been the prototype for similar systems being developed for coastal areas and estuaries both in the US and around the world.

2. NOBOBs research and initiation of Center for Aquatic Invasives

NOAA established a new NOAA National Center for Research on Aquatic Invasive Species headquartered at GLERL in Ann Arbor, Mich. The center will allow NOAA to more effectively organize and coordinate its aquatic invasive species research efforts while assuring that NOAA resources are focused on priority problems nationwide, and where appropriate, form partnerships with other agencies, academia and the private sector.

One of the first activities at the Center has been the investigation of ballast water in ocean-going vessels in the Great Lakes as a possible vector for introduction of nonindigenous species. However, on average, less than 10% of ocean vessels entering the Great Lakes in recent years have contained declarable ballast water on board. These other vessels, known as "NOBOBs" (NO-Ballast-On-Board), escape scrutiny under existing U.S. and Canadian federal, state, and provincial laws and regulations, yet their ballast tanks may retain residual volumes of unpumpable ballast water and sediment that also contain live aquatic organisms and eggs representing numerous previous ballasting operations.

During the 2001 shipping season 22 vessels were sampled for residual ballast material in 43 ballast tanks. Ballast management surveys will also be completed on 61 vessels. Generally, total ballast residuals were <1% of total ballast capacity in those tanks entered and visually assessed, and the sediment component was estimated to be <50% of total residual. Participation of shipping industry, access to vessels, and cooperation of captains and crews was outstanding. Live organisms found in residual ballast samples or hatched in the lab are being identified as indigenous, nonindigenous but already established, or nonindigenous, to the Great Lakes, a critical step towards risk assessment. Identification work is underway and ongoing.

Customers: The major stakeholders and client communities for the issue of nonindigenous species introduction via ballast water include the ship-owners, management agencies (federal and state), policy-makers, the scientific community, the news media, and the public at large. To insure on-going, two-way communication with major stakeholders, an Advisory Panel of representatives from the government, shipping industry, and policy sectors was formed. To insure regular exchange of findings and ideas with scientists working on related projects, GLERL has established communications links and holds meetings with scientific teams of related projects, as appropriate and cost effective. In addition, numerous public briefings on this project and results have and will continue to be presented, including the presentations to the U.S. Coast Guard, the ANS Task Force, the shipping and vessel operator communities, the scientific community, and the international community.

Significance: The National Center will coordinate all of NOAA's research activities and form a NOAA National strategy. This research will help guide decision makers and regulators on the need and type of protective steps that may be required to reduce or eliminate the potential for NOBOB-induced species introductions. It will also educate ship owners and operators about the issue and provide them with options (best management practices) to reduce the amount of residual ballast material, especially sediments.

3. Publishing Great Lakes Ice Atlas

In 2003 the 30-year winter ice cover data and ice climatology were made available as an electronic atlas. The Graphic User Interface for that atlas was completed this year making it possible to browse the climatology and database on the Internet and download data. It was also made available on CD-ROM. Several Technical Memorandums were written to supplement the electronic ice atlas and provide detailed documentation of analysis methods and additional analysis products not included in the atlas. The new database and climatology were presented at scientific and technical conferences.

Customers: The updated climatology has been made available to the National Ice Center and Canadian Ice Service who have the responsibility of making long-range ice cover outlooks and forecasts for the Great Lakes each winter. Other customers include government agencies (Army Corps of Engineers for research and engineering applications), academia (e.g., Dr. Stephen S. Crawford, Axelrod Institute of Ichthyology University of Guelph Guelph, Ontario, for time series analyses on the effects of environmental conditions on year-class strength and recruitment of lake whitefish populations in Lake Huron), and private industry (e.g., Trevor Elliott, Baird & Assoc., Oakville, Ontario Ca., for modeling the effect of ice on shore erosion, part of the federally funded International Joint Commission Lake Ontario project) with research, educational, operational, and engineering activities in which Great Lakes ice cover is an important consideration. In FY03 the entire atlas was prepared for release to the public on CDROM and the Internet.

Significance: Updated statistics on Great Lakes ice cover will be a National resource for research, engineering, and educational information on Great Lakes ice cover.

4. Completion of Episodic Events—Great Lakes Experiment (EEGLE) program

Purpose: The EEGLE program was designed to quantify the impacts of major late winter-early spring storms on sediment-water exchange, nearshore-offshore transport and subsequent influence on the lakes' productivity. At the beginning of the program, it was generally agreed that episodic resuspension and subsequent transport of the large inventories of nutrients and contaminants deposited over the past few decades (e.g. P, 137Cs, PCBs), would result in greater fluxes to the water column than from all external inputs. In addition, control of biological processes could occur as a result of effects on light and substrate availability and the introduction of plankton species from resting stages in the sediments.

Efforts: The EEGLE program was coordinated by NOAA-GLERL, with support from NOAA-Coastal Ocean Program and the National Science Foundation-Coastal Ocean Processes Program. It included a pilot field year, two full field years and two years of subsequent interpretations and product development. EEGLE program components include a retrospective analysis of satellite imagery, water intakes, and other historical data, process and survey cruises, moored current meters, traps and data acquisition instruments and coupled hydrodynamic/sediment transport/ecological modeling. There were 41 investigators from 17 institutions participating in this interdisciplinary project. During the three field years, the program was fortunate to have the opportunity to examine a very large event in March 1998, a smaller than average event in March 1999, and another large event in April 2000. The relatively small 1999 event allows for an interesting contrast to the large 1998 and 2000 events. During 1999 and 2000, GLERL had successful survey cruises before, during and after the event, along with a number of process cruises. Our observation strategy consisted of three components: (1) moored arrays of current meters, thermistors and sequencing traps, (2) interdisciplinary Lagrangian measurements, and (3) shipboard surveys. In addition, survey, and process measurement cruises were conducted along with special cruises for ROV sediment-water interface sampling, particle transformation measurements, and collection of sediments. The time series and survey data have been supplemented by synoptic coverage from satellite imagery and multi-frequency HF radar

observations. Water samples for standard analyses and Plankton Survey System (PSS) tows for turbidity and plankton density estimates in cross-shelf transects will continue on a monthly basis throughout the year. All data collected during the program has been archived and is ready for release to the scientific community. A dedicated journal volume of scientific papers is in press.

Customers: The Great Lakes and many marine coastal systems are already extensively managed systems. Attempts to balance the needs of multiple uses within these systems can only grow as population increases. Understanding major processes controlling internal recycling are critical in any overall ecological management effort. In order to disseminate and test the results of this 6-year program, special sessions have been convened at four international scientific meetings ASLO-99 in Santa Fe, NM, Feb., 1999, IAGLR-99 in Cleveland, OH, May, 1999, Ocean Sciences in San Antonio, TX Feb., 2000, and Societies Internationale Limnologie in Melbourne, Australia. The program has communicated with the interested public via presentations, newspaper articles and radio. In order to promote interdisciplinary activities, the program has held several all-hands meetings of several days duration: Milwaukee, WI Oct., 1997, Ann Arbor, MI Oct., 1998, Minneapolis, MN Oct., 1999, Glen Arbor, MI Aug., 2000, and Argonne National Lab, Dec, 2000. The NSF-CoOP Steering Committee, and their invited experts, attended our meeting in Minneapolis and provided some feedback. For more on EEGLE, please visit our extensive website: www.glerl.noaa.gov/eeagle.

Significance: Overall, the program is designed to provide the most comprehensive insight into the hydrodynamics of cross-margin transport, transformation and ecological consequences of biogeochemically important substances ever accomplished on the Great Lakes.

5. Research on disappearance of Diporeia

Purpose: The purpose of this long-term research is to determine distributions of the important amphipod Diporeia throughout Lake Michigan and assess changes that had occurred over the past 5 years. Diporeia is the dominant benthic macroinvertebrate and a keystone component of the food web in the offshore waters of most of the Great Lakes. From earlier studies, GLERL documented that this species was declining in the southern basin of the lake, and efforts in 2000 focused on determining whether it was also declining in other lake regions.

Efforts: In July/August 2000, 160 sites were sampled throughout Lake Michigan. Most of the 85 sites that were sampled in 1994/95 were re-sampled. Additional sites established along transects between 20 and 80 m water depth were also sampled. These depths correspond to the depths at which most fish species that feed on Diporeia are found. A large number of sites established in northern Green Bay and Grand Traverse Bay were also sampled. Both bays are commercially fished for lake whitefish, a species that relies heavily on Diporeia as a food source.

Customers: Managers involved with maintaining healthy, sustainable fish populations will be interested in knowing the lakewide status of Diporeia. Besides the above-mentioned lake whitefish, other species such as sculpin, bloater chub, smelt, and alewife also feed on Diporeia. These species provide the forage base for the salmonines, which form the basis of a large sport fishery. In addition, the presence of Diporeia is an indicator of a healthy ecosystem as defined by the Great Lakes Water Quality Agreement.

Significance: The lakewide decline of *Diporeia* could have profound implications for the Lake Michigan web. *Diporeia* is an easily attainable, high-caloric food source. With the loss of this species, GLERL's research has demonstrated that fish would need to feed on alternate food items, thereby creating competitive interactions and changing trophic transfer efficiencies within the Lake Michigan ecosystem and loss of fish production.

Success: GLERL discovered that the *Diporeia* population in Lake Michigan declined by 68 %. Overall declines within various water depth intervals (meters) were as follows: 71 % at < 30 m, 84 % at 31-50 m, 60 % at 51-90 m, and 44 % at >90 m. Decreases were noted in most all portions of the lake, but the greatest decline occurred in the north. *Diporeia* was rare or completely gone from Green Bay, Grand Traverse Bay, and shallower regions (< 50 m) of the northern basin. These areas have a large commercial lake whitefish fishery, and the decline of *Diporeia* is already having an impact on lake whitefish distribution, condition, and growth.